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Project 6.8

EVALUATION OF U. S. ARMY FIELD WATER SUPPLY EQUIPMENT AND OPERATIONS

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OPERATION JANGLE

PROJECT 6.8

EVALUATION OF U. S. ARMY
FIELD WATER SUPPLY EQUIPMENT AND OPERATIONS

By

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15 MAY 1952

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PREFACE

This investigation was conducted to determine the resistance of GRS coated nylon fabric 3000 gallon water tanks to the blast and thermal effects of an atomic burst on the surface of the ground, and to evaluate U. S. Army Water Purification Equipment, Diatomite, Pack (Man), 15 GPM, Set No. 2, for removing radioactive contamination from water.

In addition, the potential problem of radioactive contamination of field water supplies following a highly contaminating atomic burst on the surface or under the ground was investigated and is reported on herein.

Test installations and operations were accomplished with the able assistance of M/Sgt R. H. Dean, Sgt F. L. Cobler, Cpl C. E. Graham, and Cpl H. M. Griffin. Active cooperation and help in accomplishing this investigation were given by the Special Projects Branch of the Engineer Research and Development Laboratories, the Weapons Effects Division of the Armed Forces Special Weapons Project and the Signal Corps Engineering Laboratory. Radioactivity counts were made by C. L. Blair, E. E. Anderson, PFC J. R. Coleman, and PFC J. J. Drexler of the Signal Corps.

PROJECT 6.8

CONTENTS

PROJECT 6.8

ILLUSTRATIONS

TABLES

ABSTRACT

An investigation was conducted under Project 6.8, Operation JANGLE to determine the resistance of coated fabric water tanks to the blast and thermal effect of an atomic burst on the surface of the ground, to evaluate a standard U. S. Army water purification unit for removing radioactive contamination from water and to determine if field water supplies may become contaminated following a surface or underground burst.

U. S. Army 3000 gallon GRS coated nylon fabric water tanks filled with water were undamaged at a distance of 500 yards from ground zero for a 1.2 KT atomic ground surface burst. Thus these tanks withstood overpressure as high as 5 psi and thermal flux of 20 cal/cm^2.

U. S. Army Water Purification Equipment, Diatomite Pack (Man), 15 GPM, Set No. 2, was found capable of removing 84.5 per cent of the activity of a field water supply deliberately contaminated to greater than seven times the safe drinking tolerance.

A field water supply may become contaminated to a significant degree as a result of fall-out of radioactive material following a surface or underground atomic burst if in a down-wind position from the burst.

CHAPTER 1

FIELD WATER STORAGE TANKS

1.1 OPERATIONS

Four standard U. S. Army GRS coated nylon fabric, 3000 gallon water tanks were placed on a line 50° East of North from ground zero at distances of 500, 925, 1500, and 2030 yards (see Figure 1.1). The tanks were filled with local drinking water (from 500 foot wells at Frenchman Flat) and left uncovered. In addition, one covered 3000 gallon tank was installed at the 500 yard site. All tanks were placed on ground level and were not fortified or "dug in".

1.2 RESULTS

The tanks were essentially undamaged following the 1.2 KT atomic burst on the surface of the ground. This detonation produced an overpressure of 5 psi and thermal flux of 20 cal/cm^2 at a distance of 500 yards from ground zero. The top cover sheet of the covered tank at 500 yards from ground zero was partially torn from the ring loops and had dropped into the tank. The wood staves facing ground zero were slighly charred. Figure 1.2 and Figure 1.3 show the undamaged condition of the tanks located 500 yards from ground zero.

1.3 CONCLUSION

Standard U. S. Army 3000 gallon GRS coated nylon fabric water tanks filled with water can withstand a 1.2 KT atomic surface burst at distances of 500 yards or more from ground zero without damage (overpressure 5 psi, thermal flux 20 cal/cm^2).

PROJECT 6.8

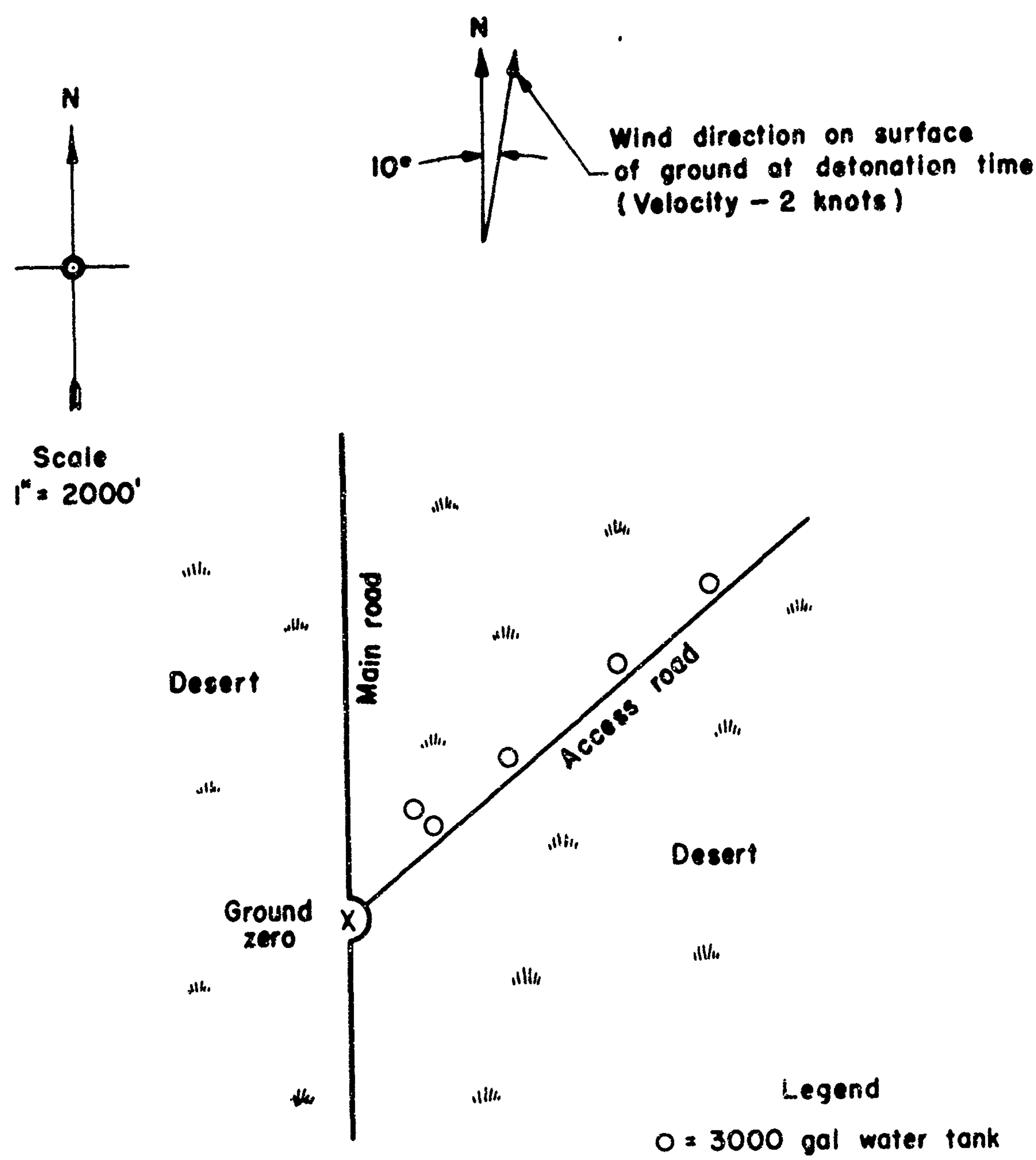

Fig. 1.1 Map-layout of Water Tanks for Jangle 6.8 (Nevada Test Site)

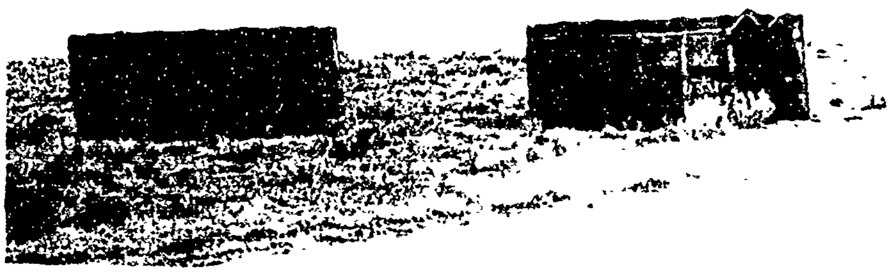

Fig. 1.2 Post Shot Photograph of Tanks at 500 Yards From Ground Zero. (Cover Sheet on Tank on the Right Partially Torn From Ring Loops.)

Fig. 1.3 Post Shot Photograph of Side of Tank Facing Zero at 500 Yards. (Note Sagebrush Blown Behind Stave While Tank was Distorted During Peak Overpressure Period)

CHAPTER 2

FIELD WATER PURIFICATION EQUIPMENT

2.1 OPERATIONS

In order to evaluate the Water Purification Equipment, Diatomite Pack (Man), 15 GPM, Set No. 2, it was necessary to deliberately contaminate a supply of water. This contaminated water supply was purified by a procedure consisting of slurrying with powdered iron, coagulating with ferric chloride and limestone, and filtering with diatomite. In addition, data on the decay of the radioactivity of the contaminated water was secured for comparison purposes.

2.1.1 Deliberate Contamination

Approximately 70 pounds of lip material taken from near ground zero 26 hours after the atomic surface burst was added to 3000 gallons of water in the test tank at 925 yards from ground zero, agitated, and settled. A radiac survey instrument read 20 r/hr directly above the 70 pounds of lip material. After deliberate contamination of the water, a radiac survey instrument read 100 mr/hr directly above the tank.

2.1.2 Slurrying With Powdered Iron

Ten pounds of powdered iron was placed in the bottom of a 500 gallon canvas tank, and the tank filled with contaminated water from the 3000 gallon tank. After filling, which was accomplished in twelve minutes, the 500 gallons of water was vigorously agitated for 18 minutes by recirculating the water with the same pump used for filling. The water was then allowed to settle for twenty minutes.

2.1.3 Coagulation

Approximately 450 gallons of the supernatant from the 500 gallon canvas tank was pumped into another 500 gallon tank and treated with one pound five ounces of pulverized limestone and ferric chloride ($FeCl_3 \cdot 6 H_2O$) in the estimated amount of two pounds. This high dosage of chemicals is considered to be practical for decontaminating purposes. The floc formed was of excellent quantity and quality and settled well during the twenty minute settling period allowed. The chemicals used are not standard with the Water Purification Equipment, Diatomite, Pack

(Man), 15 GPM, Set No. 2 but are expected to become standard with new water purification equipment now being developed by the Corps of Engineers. The conditions of this test did not permit the use of the standard coagulants, ammonium alum and soda ash which would be expected to produce similar results but require more trials for optimum results.

2.1.4 Filtration

After settling, the supernatant was filtered through the diatomite filter in accordance with standard practice. The elements were precoated with six ounces of standard diatomite and a body feed dosage of four ounces was employed.

2.1.5 pH and Alkalinity

The pH and alkalinity of the water at various stages in the purification process is shown in Table 2.1.

TABLE 2.1

The pH and Alkalinity of Water Used in Evaluation of Water Purification Process

Sample	pH	Alkalinity (total)
Contaminated Water	8.5	216
After Slurrying with Powdered Iron	8.3	218
After Coagulation	6.5	112
After Diatomite Filtration	6.5	110

2.2 RESULTS

The radioactivity count of the water originally contaminated to 2.59×10^{-2} microcuries per ml by addition of lip material from the atomic surface burst was reduced by 84.5 per cent to 4.00×10^{-3} microcuries per ml in the purified water. Complete data on radioactivity measured at various stages in the purification process is shown in Table 2.2. Decay of samples from the water purification process is shown in Table 2.3.

PROJECT 6.8

TABLE 2.2

Radioactivity Count in Water Samples from Water Purification Process

Sample	Gross Beta-Gamma Activity	
	Microcuries per ml	D/M/Ml
Contaminated Water:		
Suspended Turbidity	1.74×10^{-2}	38500
Dissolved	0.85×10^{-2}	18820
Total	2.59×10^{-2}	57320
After Slurrying with Powdered Iron (Filtrate from laboratory filtration)	0.86×10^{-2}	19100
After Coagulation (Filtrate from laboratory filtration)	3.81×10^{-3}	8450
Purified Water after Diatomite Filtration	4.00×10^{-3}	8880

Note: Count corrected for background, coincidence, standard factor, and to 100% geometry.

PROJECT 6.8

TABLE 2.3

Decay of Samples from Water Purification Process

Hours after Contamination of Water in Tank	Sample	Gross Beta-Gamma Activity D/M/ml
5.92	Contaminated water (suspended turbidity from laboratory filtration)	38500
30.75	" "	32870
45.20	" "	27036
69.75	" "	19630
6.62	Contaminated water (filtrate from laboratory filtration)	18820
30.92	" "	9327
45.15	" "	7589
69.87	" "	5613
7.0	Purified Water	8880
30.87	" "	4472
45.20	" "	3315
69.76	" "	2204

Notes: 1. Reservoir tank contaminated 26 hours after detonation.

2. Count corrected for background, coincidence, standard factor and to 100% geometry.

3. No alpha count in any of the samples.

A measure of the efficiency in terms of time for this means of decontamination of water supplies as compared to gross decay is shown graphically in Figure 2.1. By processing with Water Purification Equipment Diatomite, Pack (Man), 15 GPM, Set No. 2, decontamination of water was accomplished in less than two hours, whereas natural decay of radioactivity of the contaminated water to the same level would have taken considerably in excess of three days.

2.3 CONCLUSIONS

Although it was not the purpose of this evaluation to determine whether or not this equipment eliminates all physiological hazard from radioactively contaminated drinking water, it has been shown that the equipment is entirely adequate for military field use when used by competent and trained personnel.

It is recommended that care be taken in operating purification equipment in the field to prevent recontamination of the final purified water. The purified water tank should be kept covered at all times, and water from the filter should be run to waste for a few minutes when first starting operations.

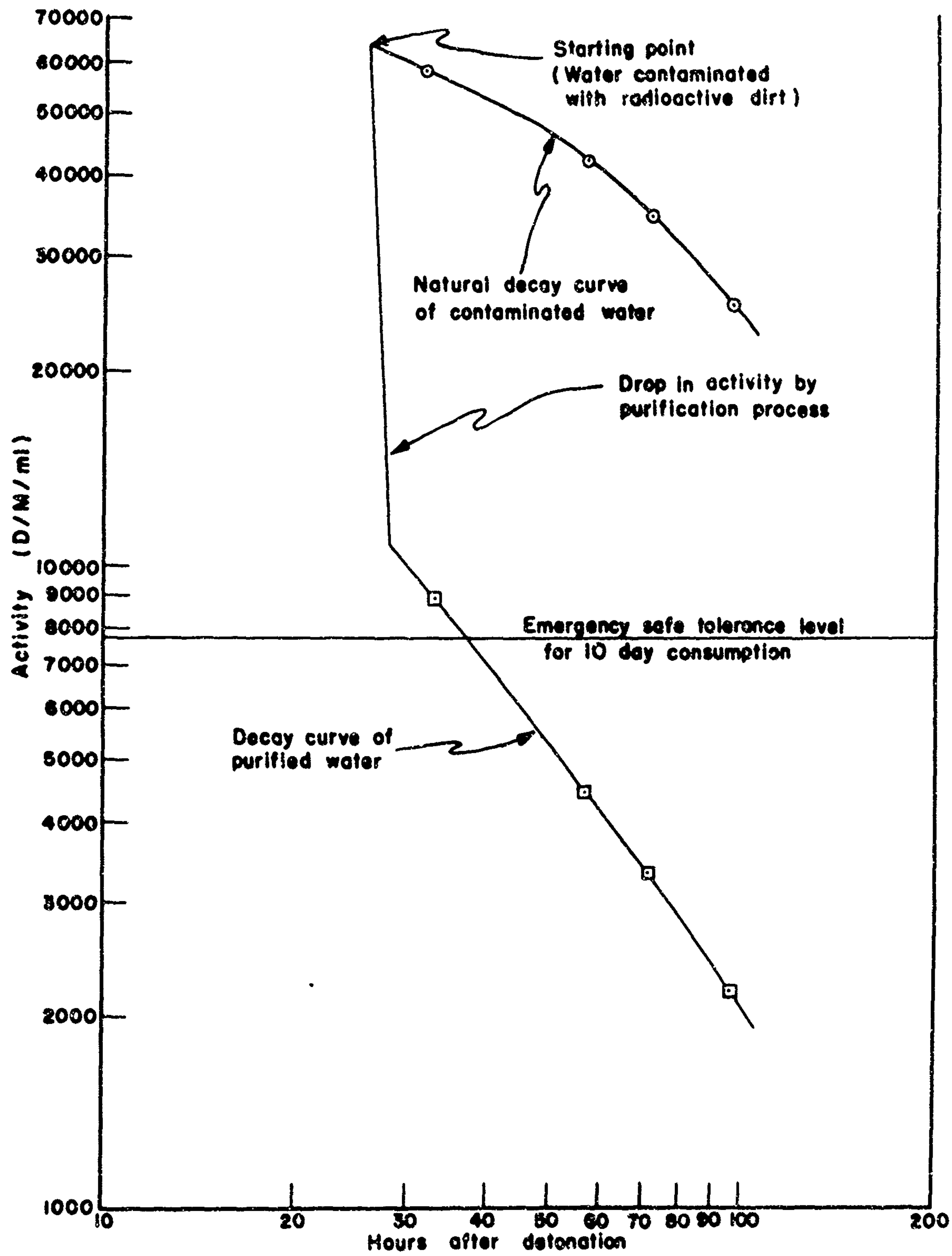

Fig. 2.1 Natural Decay of Contaminated Water vs Purification Process

CHAPTER 3

RADIOLOGICAL CONTAMINATION OF FIELD WATER SUPPLY

3.1 RADIOACTIVITY TOLERANCES

The conclusions of a careful study of the levels of radioactivity permissable in drinking water made by Mr. W. F. Bale, Division of Biology and Medicine, Atomic Energy Commission, are summarized in Table 3.1. These tolerances are considered to be very conservative and contain a substantial factor of safety. They are based on the ingestion of radioactive strontium isotopes which are among the most physiologically damaging of all the radio isotopes.

TABLE 3.1

Proposed Emergency Levels for Beta-Gamma Activity in Drinking Water In Period Immediately Following Bomb Blast (After Bale)

Time Water is to be consumed	Safe		Low Acceptable Risk	
	Microcuries/ml	D/M/ml	Microcuries/ml	D/M/ml
10 Days	3.5×10^{-3}	7.7×10^{3}	$9. \times 10^{-2}$	$2. \times 10^{5}$
One Month	1.1×10^{-3}	2.6×10^{3}	$3. \times 10^{-2}$	$7. \times 10^{4}$

Note: D/M/ml is disintegrations per minute per milliliter.

3.2 CONTAMINATION

No activity was found in the water contained in the five tanks exposed to the 1.2 KT surface burst. This was due to the fact that the tanks were not in the direct path of the fall-out of radioactive material. Contamination would undoubtedly have occurred had the tanks been placed downwind from ground zero.

No water tanks were set out for the underground burst. However, certain ground contamination data were collected by Project 2.8, Operation JANGLE, "Analysis of Test Site and Fall Out Material". These data indicated that the heaviest contamination took place 1/2 mile downwind from ground zero where the fall-out was 37.50 grams per square foot with a specific activity of 4.23×10^{5} disintegrations per second per gram at

detonation time plus 28 days. Extrapolation by means of the mixed fission product decay law ($A = A_1 t^{-1.2}$) places this specific activity at 1.05×10^9 disintegrations per second per gram at detonation time plus one hour. Sieve size data of the material indicated that 8 per cent consisted of silt or clay particles less than 0.05 mm in diameter.

From these data a calculation of the degree of contamination in a field water supply located one half mile downwind from ground zero would show 1.67×10^6 D/M/ml at detonation time plus one hour. This calculation is based on the assumption that 8 per cent of the fall out material would dissolve or become suspended in the water. It is also assumed that the water supply is 4 feet deep (the depth of water in a 3000 gallon tank). The figure 1.67×10^6 D/M/ml is above emergency tolerance figures. Using the standard decay law for mixed fission products it is calculated that the activity would decrease to the 10 day "acceptable risk" emergency tolerance of $2. \times 10^5$ D/M/ml in 5.9 hours. It would require 88.0 hours to decrease to the 10 day "safe" emergency tolerance of 7.7×10^3 D/M/ml. These data are summarized in Table 3.2 which also contains external dosage data obtained from the preliminary Jangle report.

TABLE 3.2

Summary of Computed Data-Contamination of Water by 1.2 KT Underground Burst

Hours after Detonation	Contamination of Water D/M/ml	r/hr (Due to Ground Contamination)
1.0	1.67×10^6	700
5.9	$2. \times 10^5$ (acceptable risk)	83
88.0	7.7×10^3 (safe)	32

Note: Above data for 1/2 mile downwind from ground zero.

3.3 CONCLUSIONS

Army field water supplies in GRS coated nylon fabric 3000 gallon water tanks may be contaminated to a significant level following a surface or underground atomic burst at distances at which the tanks are undamaged. Contamination will occur as a result of fall-out of radioactive material into tanks located in a downwind direction from ground zero.

Such a water supply located in an area contaminated to a level of 83 r/hr or greater following an atomic burst would be unsafe for drinking purposes until analysis for radioactivity proved otherwise.

3.4 RECOMMENDATIONS

A suitable instrument for field use for measuring radioactivity in drinking water supplies should be developed for use by field troops.

Standard operating procedures for installation of field water supply points should provide for dispersal of the points crosswind to the prevailing winds in the area at appropriate distances apart.

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